

Optimization of food waste fermentation for the maximum production of volatile fatty acids: effect of anaerobic sludge, temperature, pH, and total solids content



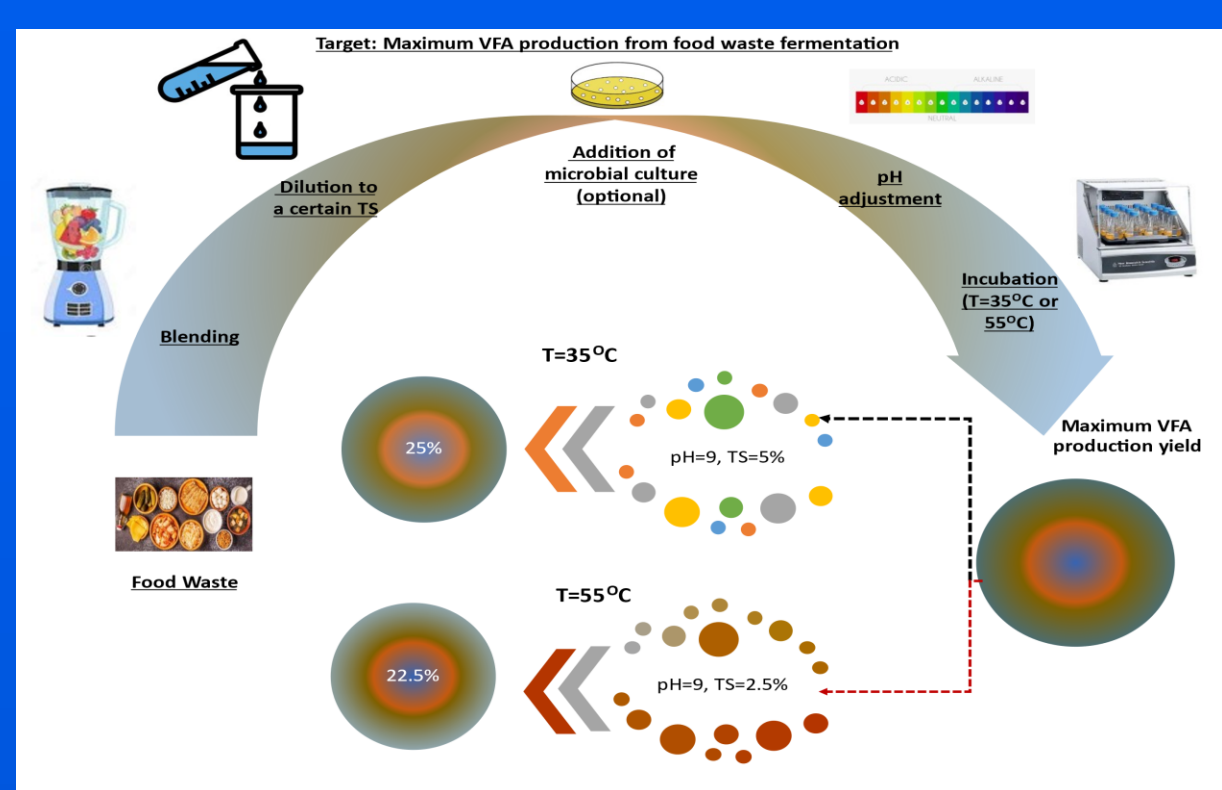
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Introduction



This study focused on the maximum production of volatile fatty acids (VFAs) from food waste fermentation based on process parameter control: the temperature, the pH value, and the total solids content of the fermentation reactor, as well as the anaerobic sludge presence as inoculum were examined during the fermentation. VFAs are a group of carboxylic acids, valuable for various applications, such as the production of eco-friendly bioplastics, and the generation of bioenergy. They commonly derive from fossil fuel sources via chemical routes, but the fermentation of rich organic wastes, such as food waste (FW), is a promising process for their production, too. FW is a well-studied organic substrate for biogas production, but there is not enough literature on the production of VFAs from it. It is the most generated type of bio-waste in the EU, and its disposal causes environmental pollution. However, due to its abundance and great variety, it is ideal as a low-cost raw material for producing valuable substances, such as VFAs.

Figure: Experimental procedure of food waste fermentation for maximum VFA production

Results & Discussion

The maximum VFA production yield is specified as the maximum concentration of VFAs produced divided by the initial TS concentration in each reactor $[(gVFAs_{max}/L)/(gTS_{initial}/L)]$.

To evaluate this yield, the following process parameters were examined:

- ▶ The use of anaerobic sludge as inoculum both in $T=35^{\circ}C$ and $T=55^{\circ}C$
- ▶ The test of acidic and alkaline pH values both in $T=35^{\circ}C$ and $T=55^{\circ}C$
- ▶ The test of different Total Solids content in the reactor both in $T=35^{\circ}C$ and $T=55^{\circ}C$

From the examination of the process parameters (T, pH, TS) and the presence of inoculum, the following results were obtained:

- ▶ The addition of anaerobic sludge was not proven to be beneficial.
- ▶ The effect of pH is quite notable in both temperatures ($35^{\circ}C$ and $55^{\circ}C$), with the alkaline values being more favorable for VFA production.
- ▶ The highest VFA production yield for a pH value equal to 9, was achieved in mesophilic conditions for $TS=5\%$, and it was 25%. The next highest yields were achieved for $TS=2.5\%$ both in mesophilic and thermophilic conditions.



Figure 2: Maximum VFA production yields in FW fermentation, with and without the addition of anaerobic sludge, in mesophilic and thermophilic conditions

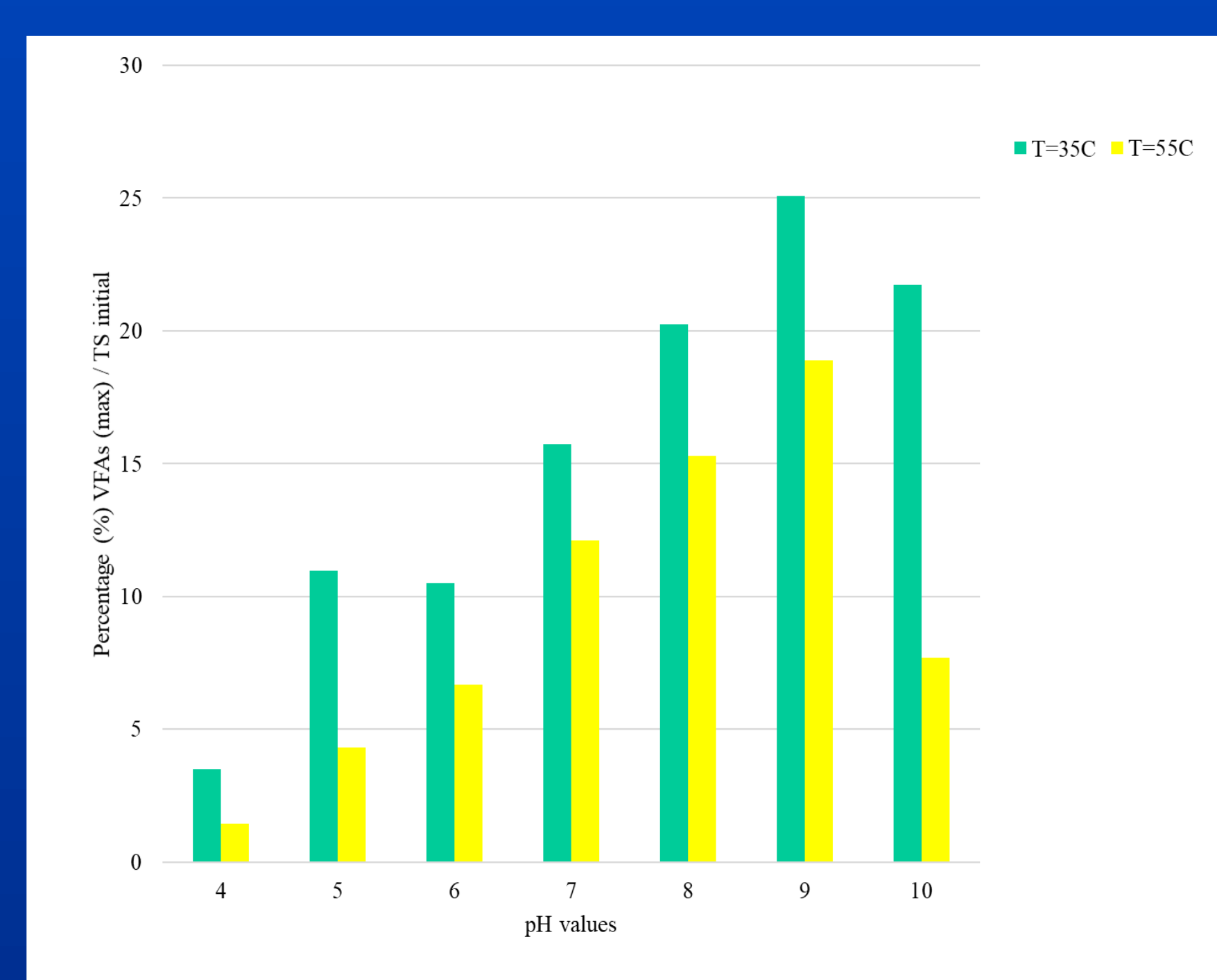


Figure 3: Maximum VFA production yields in FW fermentation, at different pH conditions, in mesophilic and thermophilic temperature

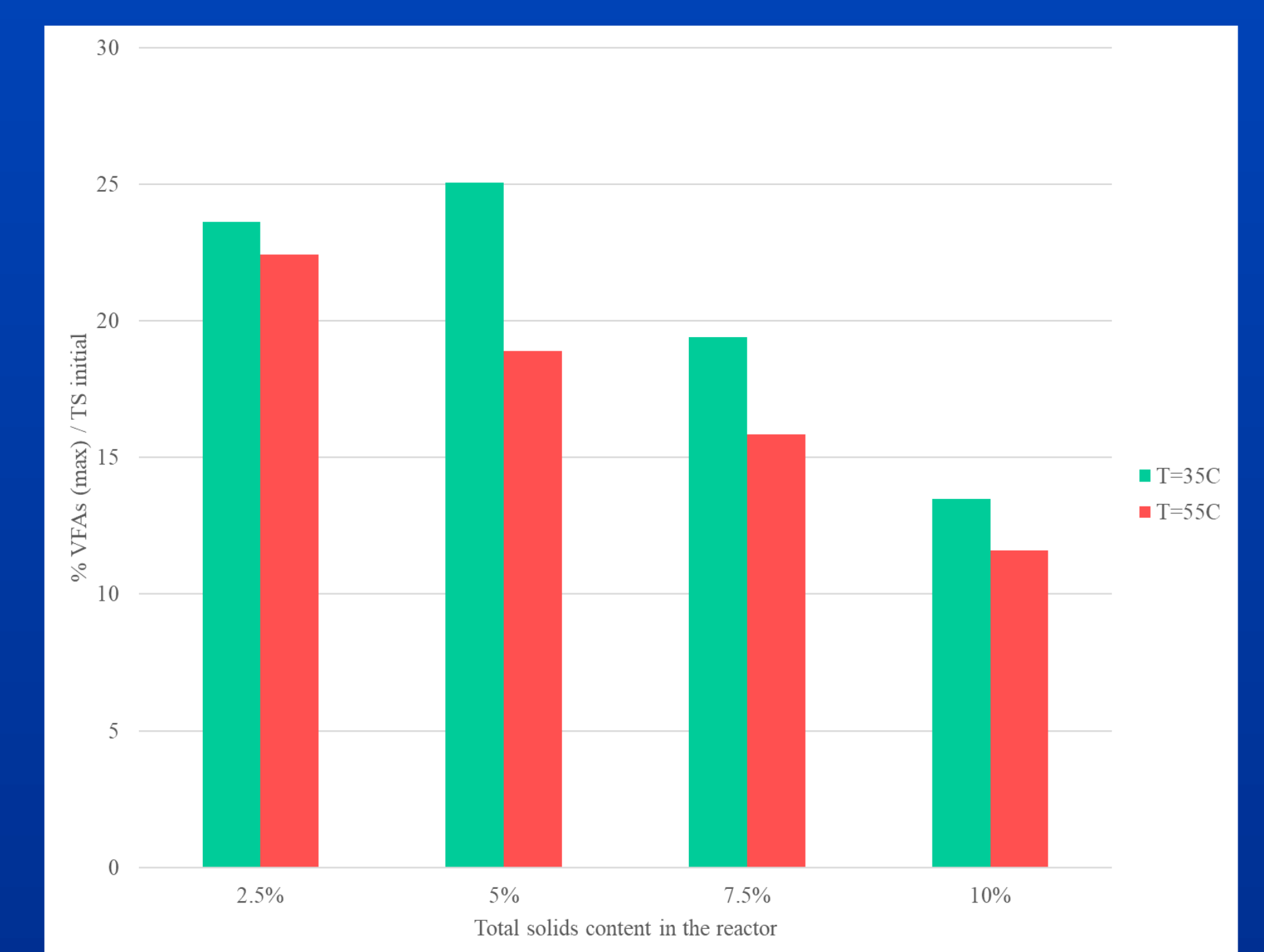


Figure 4: Maximum VFA production yields in FW fermentation with different TS content, in mesophilic and thermophilic temperatures, and with adjusted pH=9

Conclusions

The temperature, the pH value, the total solids content, and the presence of anaerobic sludge as inoculum were examined for the maximum VFA production via food waste fermentation. It was proven that the optimum system of parameters was the following: $T=35^{\circ}C$, $pH=9$, $TS=5\%$, and no addition of anaerobic sludge. For these parameters, the maximum VFA production yield was equal to 25% and was detected on the 10th day of the fermentation process. VFA production from food waste fermentation is an open field for more investigation by the scientific community.

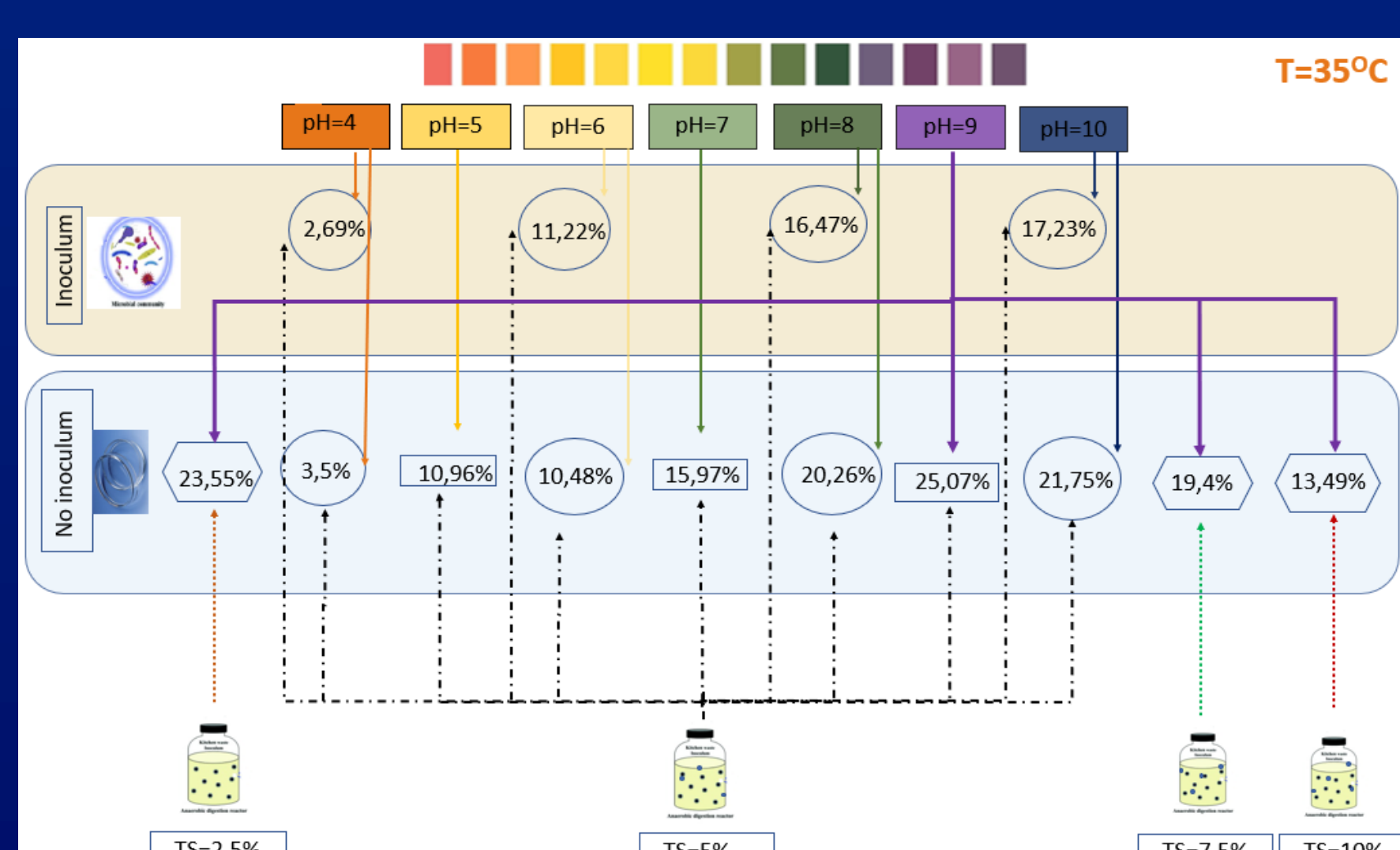


Figure 5: Percentages of the maximum VFA production yields for every system of pH, TS, and inoculum in the mesophilic conditions

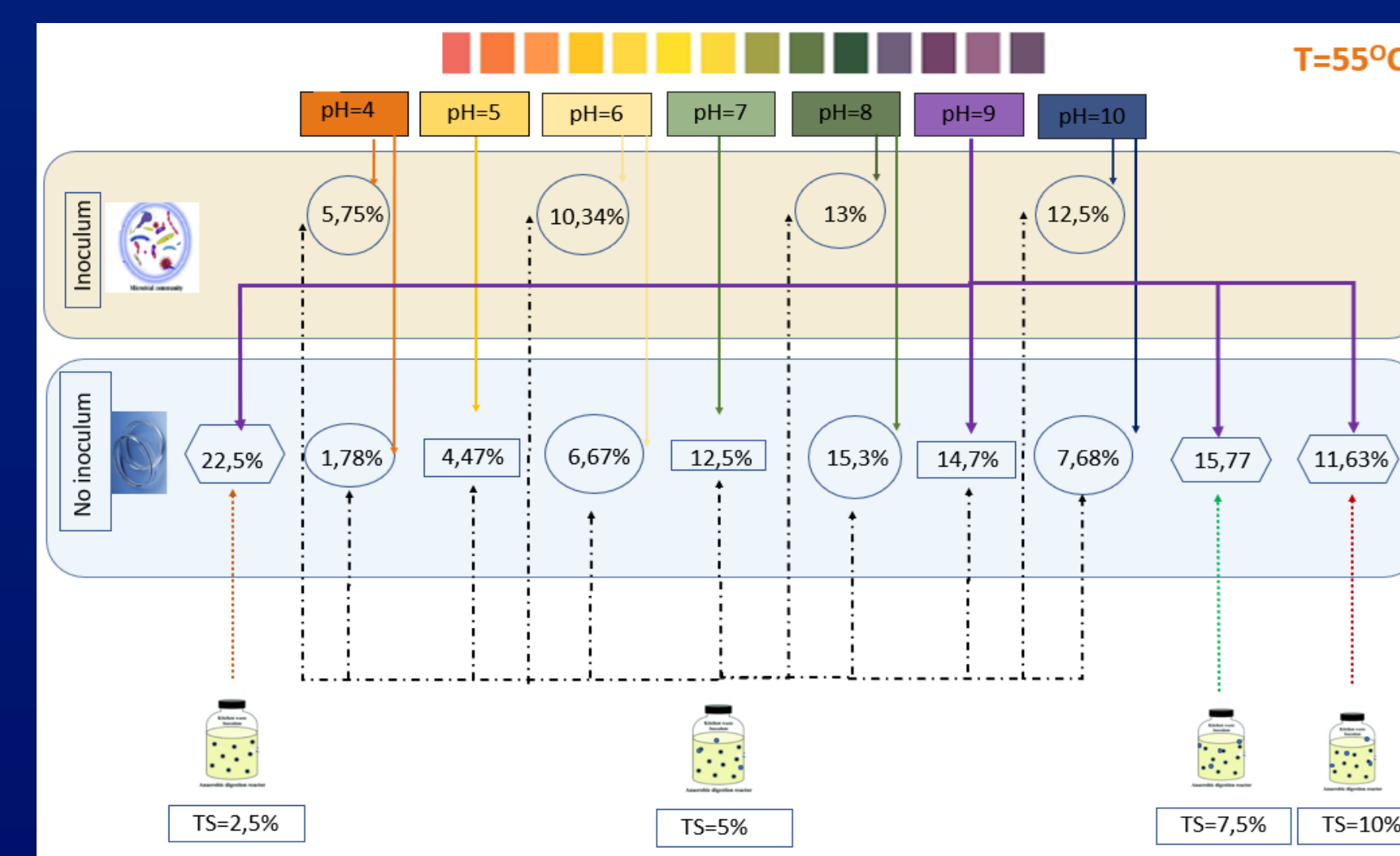


Figure 6: Percentages of the maximum VFA production yields for every system of pH, TS, and inoculum in the thermophilic conditions